Geographic range and seasonal occurrence in British Columbia of two exotic ambrosia beetles as determined by semiochemical-based trapping

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ABSTRACT

Two exotic ambrosia beetles, *Trypodendron domesticum* (L.) and *Xyloterinus politus* (Say) (Coleoptera: Curculionidae: Scolytinae), were captured in 2004 in traps baited with either ethanol alone or ethanol and the aggregation pheromone lineatin at locations outside their known range. The range of *T. domesticum* in British Columbia is now known to extend along lower Fraser Valley as far north as Yale and along the Highway 3 corridor as far east as Sunshine Valley. *Xyloterinus politus* was not recovered east of Hope but was trapped as far north as North Bend in the Fraser River Canyon. Neither species was found on the Sunshine Coast or on Vancouver Island. Traps on the Simon Fraser University (SFU) campus captured *T. domesticum* as early as the week ending 17 February 2004. At both SFU and the University of British Columbia's Malcolm Knapp Research Forest (MKRF) in Maple Ridge, the majority of *T. domesticum* were captured well before peak flight of the native striped ambrosia beetle, *Trypodendron lineatum* (Olivier). The flight of *X. politus* occurred much later, spanning the months of April and May. Catches of 4,716 *T. domesticum* in three traps at SFU and 59 X. politus at the MKRF indicate successful establishment of both species. In future, the presence of both species will demand expert taxonomic identification as a prerequisite to implementation and interpretation of pest management tactics to prevent ambrosia beetle damage on conifer and hardwood logs and lumber.

Keywords: exotic ambrosia beetles, *Trypodendron domesticum*, *Xyloterinus politus*, British Columbia

INTRODUCTION

Two exotic ambrosia beetles in the tribe Xyloterini (Coleoptera: Curculionidae: Scolytinae), *Trypodendron domesticum* (L.) and *Xyloterinus politus* (Say), are established in British Columbia (BC) (Humble 2001). The former species is European in origin and has recently begun to infest living angiosperm trees, in addition to its normal dead and dying angiosperm hosts (Gaubicher *et al.* 2003; Petercord 2006). It has adapted to attack red alder, *Alnus rubra* Bong., in coastal BC (Humble 2001). *Xyloterinus politus* is native to eastern North America (Wood 1982), infests both angiosperm and gymnosperm hosts, and has adapted to attack western hemlock, *Tsuga heterophylla* (Raf.) Sarg., in BC (Henry 2004).

In surveying for the presence of exotic woodborers, Humble (2001) discovered that *T. domesticum* was already established in the BC Lower Mainland when surveys began in 1995. It was first recorded in Washington State in 2008 (Haack and Rabaglia 2013). The first *X. politus* in western North America were recovered from survey traps in Burnaby in

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1997 (Humble 2001) and from King County, Washington, in 1996 (Mudge *et al.* 2001). By 1999, both species were established in BC as far east as Ruby Creek, between Agassiz and Hope (Humble 2001).

The objectives of this study were to determine if the two species' ranges extended in BC beyond those known by 1999 (Humble 2001) and to compare the species' seasonal activity trends in one urban forest and one rural forest site to that of the indigenous striped ambrosia beetle, *Trypodendron lineatum* (Olivier).

MATERIALS AND METHODS

Geographic Distribution. Twenty-nine trapping locations were selected, mainly along four corridors leading into the BC Interior: Highway 1 (northernmost location – Lytton Lumber, south of Lytton: 50.2200° N, 121.5768° W), Highway 3 (easternmost location – Highway 3A at Okanagan Falls: 49.3337° N, 119.5549° W), Highway 5 (northernmost location – rest stop at site of former toll plaza: 49.6307° N, 121.0158° W), Highway 6 (one location – Riverside Forest Products millyard near Lumby: 50.2354° N, 119.0281° W), and Highway 99 (northernmost location – Seton Lake Road west of Lillooet: 50.6688° N, 121.9799° W), as well as on the Sunshine Coast (northernmost location – Saltery Bay: 49.7653° N, 124.3096° W) and Vancouver Island (southernmost location – Jemico Enterprises log sort yard, Chemainus: 48.9079° N, 123.7450° W; westernmost location – Sarita log sort yard on the Bamfield Road: 48.8828° N, 125.0351° W; northernmost location – Western Forest Products log sort yard near Port McNeill: 50.5762° N, 127.1942° W). Trap sites were selected near roads or sites where infested logs could have been transported or deposited and where angiosperm trees that could serve as hosts for both species were growing.

At each location, two 12-funnel Lindgren traps were placed about 35 m apart. Lures were obtained from Phero Tech Inc., Delta, BC. One trap was baited with a 40-cm-long ethanol sleeve lure (release rate 30 mg/day at 20° C, as determined in the laboratory), and the other was baited with an identical ethanol lure plus a flex lure releasing the *Trypodendron* spp. aggregation pheromone lineatin (MacConnell *et al.* 1977; Schurig *et al.* 1982; Klimetzek *et al.* 1981) at 0.02 mg/day at 20° C. Lures were positioned at the midpoint of the funnel column to achieve a wide odour plume (Lindgren 1983).

Traps were set in place by 15 March in 2004 and 2005, with trap sites altered slightly to maximize detection opportunity. Captured beetles were collected in late May and mid-July, bagged, and frozen for later identification and counting using Bright (1976) and Wood (1982) as definitive references. Sex of captured beetles was not determined. When large numbers of *Trypodendron* spp. were captured, volumetric estimates of numbers were used (80 beetles/mL) instead of individual counting. Voucher specimens of *T. domesticum* and *X. politus* captured beyond the known geographic range (Humble 2001) were deposited in the reference collection at the Pacific Forestry Centre, Natural Resources Canada, Victoria, BC.

Seasonal Flight Activity. To determine the spring to mid-summer flight season for each species, three pairs of 12-funnel Lindgren traps were set up on 9 February 2004 in predominantly coniferous forest at the University of British Columbia's Malcolm Knapp Research Forest (MKRF), Maple Ridge, BC. Three more trap pairs were set up on the campus of Simon Fraser University (SFU), Burnaby, BC, where red alder is the dominant species. Both *T. domesticum* and *X. politus* had been previously collected at each location. Traps were spaced 15 m apart within pairs, and pairs were spaced at least 35 m apart. One trap in each pair was baited with ethanol, and the other, with ethanol plus lineatin, as described above. Trap catches were collected weekly until 20 July and kept frozen for later identification and counting. Trapping did not extend into August, when the "sister" flight of re-emerged parent beetles would occur and the flight of emerged brood beetles would begin. Catches in traps with both lures were pooled to compile seasonal trend data. Catches of native *T. lineatum* were also enumerated. Temperature records were obtained from Environment Canada weather stations at both locations.

Mean catches between traps baited with ethanol or ethanol plus lineatin were compared by *t*-tests ($\alpha = 0.05$) for *T. domesticum* at SFU and *X. politus* at the MKRF.

RESULTS

Geographic Distribution. *Trypodendron domesticum* and *X. politus* represented 1.1% of the 91,339 ambrosia beetles captured, the majority of which (87,215) were *T. lineatum*. Both *X. politus* and *T. domesticum* were found beyond their previously known geographic range in BC (Table 1), the former species along the corridor of Highway 1 and the latter species along the corridors of Highways 1 and 3. Neither species was caught north of the metropolitan area of Vancouver, in the Okanagan Valley, or on Vancouver Island.

Table 1. Numbers of *X. politus* and *T. domesticum* captured in 2004 and 2005 in two locations within and four locations beyond their known geographic ranges in BC. Catches within the known geographic range are from the seasonal flight activity study.

Geographic range	Location	Year	Lure	Number captured	
				X. politus	***T. domesticum***
Within known range	Simon Fraser University, Burnaby, in forest south of South Campus Road: 49.2252° N, 122.9123° W	2004	ethanol	3	772
			ethanol + lineatin	0	3944
	Malcolm Knapp Research Forest, Maple Ridge, 1 km from gate: 49.2569° N, 122.5564° W	2004	ethanol	22	10
			ethanol + lineatin	37	18
Beyond known range	Highway 1, Hope River General Store, 5 km south of Yale: 49.5635° N, 121.4263° W	2005	ethanol	16	0
			ethanol + lineatin	6	2
	Highway 1, gas station before bridge at east boundary of Yale: 49.5627° N, 121.4181° W	2004	ethanol	1	0
			ethanol + lineatin	0	0
	Across Fraser River from Highway 1, Boston Bar First Nation log sort yard, North Bend: 49.8766° N, 121.4464° W	2004	ethanol	3	0
			ethanol + lineatin	1	0
	Highway 3, Sunshine Valley, 22 km east of Hope: 49.2720° N, 121.2274° W	2005	ethanol	0	0
			ethanol + lineatin	0	15

Xyloterinus politus was found in three new locations and in both years of trapping, while *T. domesticum* was caught in two new locations in 2005. Most *X. politus* were caught at two Yale locations, 20 and 25 km northeast of Ruby Creek – the previously known easternmost distribution of the species. Four specimens were captured at North Bend, a further 35.8 km north by road in the Fraser River Canyon from Yale. Twenty of the 24 captured *X. politus* were captured in ethanol-baited traps.

One *T. domesticum* was captured at the southernmost Yale location, and 15 more were captured at Sunshine Valley – 24 km east of Ruby Creek – and at an elevation of 914 m – 878 m higher than Ruby Creek. All were in lineatin-baited traps.

High capture numbers within the known geographic range indicated successful establishment of both species (Table 1). *Trypodendron domesticum* predominated on the SFU campus, where red alder is the most prevalent tree species, and *X. politus* was the most frequently captured species at the MKRF, where conifers predominate. At SFU, significantly more *T. domesticum* were captured in traps baited with ethanol and lineatin than in ethanol-only baited traps (means ± SE: 1,314.7 ± 166.5 *versus* 257.3 ± 60.7, N = 3, t = 6.0, df = 4, P = 0.004). At the MKRF, the difference in catches of *X. politus* in traps baited with ethanol and lineatin or ethanol alone was not significant (means ± SE: 12.3 ± 4.4 *versus* 7.3 ± 0.3, N = 3, t = 1.0, df = 4, P = 0.39).

Seasonal Flight Activity. At SFU, *T. domesticum* was captured during the first trapping period ending 17 February 2004 (Fig. 1), when the maximum temperature was only 12° C. Fifty-five per cent of 4,716 *T. domesticum* were caught before the first *T. lineatum* specimens were collected three weeks later. The 90% catch level was reached for *T. domesticum* by 27 April, whereas it took until 22 June for 90% of *T. lineatum* to be captured. The three *X. politus* captured at SFU were caught on 20 April, 27 April, and 4 May.

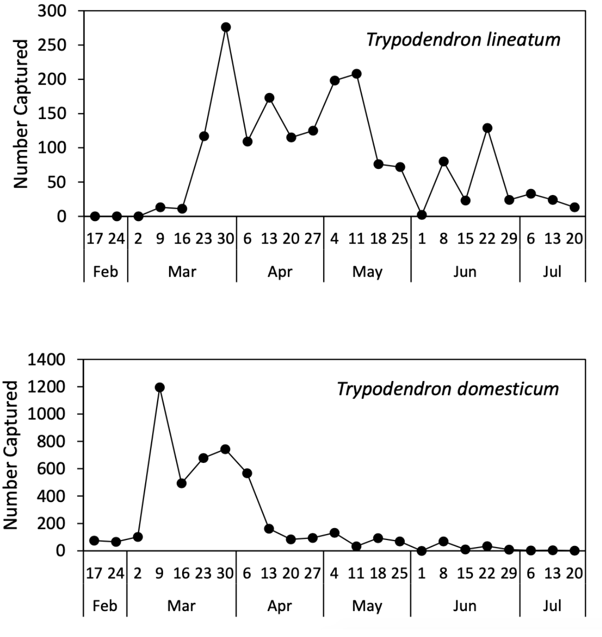

Figure 1. Seasonal occurrence in 2004 on the campus of Simon Fraser University, Burnaby, BC, of native *Trypodendron lineatum* and exotic *Trypodendron domesticum*, as determined by catches in semiochemical-baited traps.

The seasonal occurrence of *T. domesticum* at the MKRF in 2004 was similar to that at SFU, but far fewer beetles (28) were captured (Fig. 2). Although some *T. lineatum* (36 beetles) were captured in the collections on 9 and 16 March, 68% of the catch of *T. domesticum* had occurred before the first surge of 993 *T. lineatum* was collected on 23 March. *Xyloterinus politus* was first captured at the MKRF when the temperature reached 17° C, and flight extended from 13 April to 25 May (Fig. 2), coinciding with the flight period at SFU (Fig. 1).

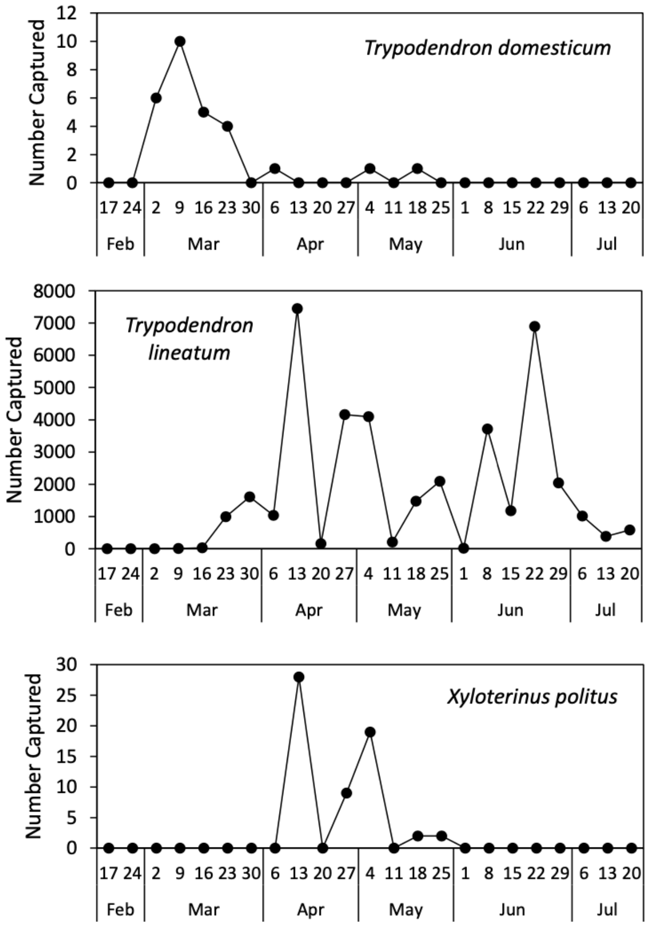

Figure 2. Seasonal occurrence in 2004 at the University of British Columbia's Malcolm Knapp Research Forest, Maple Ridge, BC, of native *Trypodendron lineatum* and exotic *Trypodendron domesticum* and *Xyloterinus politus*, as determined by catches in semiochemical-baited traps.

DISCUSSION

This study establishes that the ranges of *T. domesticum* and *X. politus* in BC are more extensive than previously known. Because past surveys (Humble 2001) did not extend east or north of Ruby Creek, it is not possible to determine if the locations identified in this study at North Bend and Sunshine Valley represent recent range expansions. *Xyloterinus politus*, which can infest both angiosperm trees and conifers, likely has the capacity to advance without human aid into the BC Interior along the Highway 1 (Fraser

River Canyon) corridor. As well, sufficient angiosperm host trees probably exist to enable the passage of *T. domesticum* into the BC Interior by way of the Highway 1 corridor. *Trypodendron domesticum*'s advancement into the interior along the Highway 3 corridor, which would demand passage through subalpine conifer forests at a minimum elevation of 1,342 m, is less likely. Another possible route into the interior, which was not sampled in this study, is by way of the Harrison Lake/Lillooet River Valley. The lack of recovery of either species on Vancouver Island and north of the Vancouver area on the mainland suggests that the Salish Sea and the large urban area, respectively, represent significant barriers to range expansion in the absence of human aid. Despite the previous collection of one *X. politus* on southern Vancouver Island by one of us (LMH, unpublished), trapping at six Island locations failed to confirm establishment.

The high catch numbers of *T. domesticum* in traps baited with ethanol and lineatin (Table 1) is consistent with the beetle's use of lineatin as an aggregation pheromone in Europe (Payne *et al.* 1983). Similarly, the very early winter–spring flight (Figs. 1, 2) reflects the same type of early flight in Europe, where *T. domesticum* flies at least one month earlier than its congener, *Trypodendron signatum* (F.) (Gaubischer *et al.* 2003). The lack of any difference in *X. politus* catches in traps baited with ethanol or ethanol and lineatin indicates that, unlike the majority of closely related *Trypodendron* species, it does not respond to lineatin.

Both species represent diagnostic and potential pest problems. Until the arrival of *T. domesticum*, *T. lineatum* and *Gnathotrichus retusus* (LeConte) (both mainly coniferophagous species) were the only ambrosia beetles known to occasionally attack and breed in red alder (Nijholt 1981; Kühnholz *et al.* 2000), a species with increasing commercial uses (FPInnovations, no date). As the range of *T. domesticum* expands in the future, any infestation in red alder logs will thus require expert diagnosis in order to implement a targeted pest management program. The response of *T. domesticum* to traps baited with ethanol and lineatin (Table 1) suggests that a mass-trapping program like that being currently run for *T. lineatum* (Borden 1988; Lindgren and Fraser 1994) could be implemented where *T. domesticum* becomes a problem. However, the 9.5° C threshold for flight (Petercord 2006) and very early peak flight in BC (Figs. 1, 2) demand that mass-trapping be implemented as early as January. Because of cross attraction by native *T. lineatum*, identification to the species level would be required in case later catches of *T. lineatum*, which flies when temperatures reach 15.5° C (Borden 1988), create the impression of an unrealistically large threat to the hardwood hosts of *T. domesticum.* In turn, without expert separation of species captured, operational mass-trapping programs directed at *T. lineatum* (Borden 1988; Lindgren and Fraser 1994) could be confounded by early catches of *T. domesticum*, creating unjustified concern that valuable conifer logs and lumber are at risk of attack much earlier than expected.

Because *X. politus* has adapted to attack western hemlock (Henry 2004), it may adapt further to embrace other BC conifers as hosts. This may necessitate identification to species level in the future, in order to implement species-specific pest management programs. Because its seasonal flight period closely overlapped that of *Gnathotrichus sulcatus* (LeConte) at the MKRF (data not shown), catches of *X. politus* responding to ethanol could confound pheromone-based mass-trapping programs directed at *G. sulcatus.*

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